

CLAIMS

What is claimed is:

1. A magnetic memory comprising:

a plurality of magnetic elements, each of the plurality of magnetic elements being
5 configured to be written using spin transfer;

at least one stress-assist layer configured to exert at least one stress on at least one
magnetic element of the plurality of magnetic elements during writing.

2. The magnetic memory of claim 1 wherein the at least one stress induces at

10 least one anisotropy on the at least one magnetic element during writing, the at least one
anisotropy reducing a total anisotropy energy perpendicular to a stable state of the at least
one magnetic element.

3. The magnetic memory of claim 1 wherein the magnetic element includes a

15 plurality of layers and wherein the at least one stress is in a direction perpendicular to a
plane of at least one of the plurality of layers.

4. The magnetic memory of claim 3 wherein at least one layer is a free layer.

20 5. The magnetic memory of claim 4 wherein the free layer includes a

ferromagnetic layer and a capping layer, the free layer having a high positive
magnetostriction.

6. The magnetic memory of claim 5 wherein the free layer has a surface anisotropy and a total anisotropy perpendicular to a stable state of the free layer, the capping layer configured to modify the surface anisotropy to reduce the total perpendicular anisotropy and capable of including Cu, Au, Pd or Pt.

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7. The magnetic memory of claim 4 wherein the at least one magnetic element includes at least one spin tunneling junction.

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8. The magnetic memory of claim 4 wherein the at least one magnetic element includes at least one spin valve.

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9. The magnetic memory of claim 4 wherein the at least one magnetic element includes at least one spin valve portion and at least one spin tunneling junction portion the at least one spin valve portion and the at least one spin tunneling junction portion sharing the free layer.

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10. The magnetic memory of claim 9 wherein the at least one spin valve portion includes a first pinned layer having a first ferromagnetic layer closest to the free layer and wherein the at least one spin tunneling junction portion includes a second pinned layer having a second ferromagnetic layer closest to the pinned layer, the first ferromagnetic layer being pinned in a first direction, and the second ferromagnet layer being pinned in a second direction opposite to the first direction.

11. The magnetic memory of claim 1 wherein the at least one magnetic element has a plurality of sides and wherein the at least one stress-assist layer surrounds the plurality of sides of the at least one magnetic element.

5 12. The magnetic memory of claim 1 further comprising:
a plurality of word write lines; and
wherein the at least one stress-assist layer resides between the plurality of word lines and the at least one magnetic element.

10 13. The magnetic memory of claim 1 wherein the stress assist layer further includes bilayer of at least one of IrO_2/PZT , MnO/PZT , TiO_y/PZT , $\text{Al}_2\text{O}_3/\text{PZT}$, $\text{Al}_2\text{O}_3/\text{PMN}$, $\text{Al}_2\text{O}_3/\text{SrBaTiO}_3$, SiO_2/PZT or $\text{SiO}_2/\text{SrBaTiO}_3$, where PZT is $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$, wherein PMN is $\text{PbMn}_{1-x}\text{Nb}_x\text{O}_3$ with PbTiO_3 and wherein x is a fraction less than 1.

15 14. A magnetic memory comprising:
a plurality of magnetic elements, each of the plurality of magnetic elements being configured to be written using spin transfer;
at least one stress-assist layer configured to exert at least one stress on at least one magnetic element of the plurality of magnetic elements during writing, the stress-assist
20 layer including at least one of a piezoelectric and an electrostrictive material.

15. A method for programming a magnetic memory including a plurality of magnetic elements, each of the plurality of magnetic elements being configured to be written using spin transfer, the method comprising:

(a) biasing at least one stress-assist layer, the at least one stress-assist layer being configured to exert at least one stress on at least one magnetic element of the plurality of magnetic elements during writing;

(b) driving a current through the at least one magnetic element while the at least one stress is exerted on the at least one magnetic element, the current being sufficient to write to the at least one magnetic element using spin transfer.

16. A method for providing magnetic memory comprising:

(a) providing a plurality of magnetic elements, each of the plurality of magnetic elements being configured to be written using spin transfer;

(b) providing at least one stress-assist layer configured to exert at least one stress on at least one magnetic element of the plurality of magnetic elements during writing.

17. The method of claim 16 wherein the at least one stress induces at least one anisotropy on the at least one magnetic element during writing, the at least one anisotropy reducing a total anisotropy energy perpendicular to a stable state of the at least one magnetic element.

18. The method of claim 16 wherein the magnetic element includes a plurality of layers and wherein the at least one stress is in a direction perpendicular to a plane of at least one of the plurality of layers.

5 19. The method of claim 18 wherein at least one layer is a free layer.

20. The method of claim 19 wherein the free layer includes a ferromagnetic layer and a capping layer and wherein the free layer preferably has a high positive magnetostriction.

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21. The method of claim 20 wherein the free layer has a surface anisotropy and a total anisotropy perpendicular to a stable state of the free layer, the capping layer configured to modify the surface anisotropy to reduce the total anisotropy and capable of including Cu, Au, Pd, or Pt.

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22. The method of claim 20 wherein the at least one magnetic element includes at least one spin tunneling junction.

20 23. The method of claim 20 wherein the at least one magnetic element includes at least one spin valve.

24. The method of claim 19 wherein the at least one magnetic element includes at least one spin valve portion and at least one spin tunneling junction portion,

the at least one spin valve portion and the at least one spin tunneling junction portion sharing the free layer.

25. The method of claim 24 wherein the at least one spin valve portion includes a first pinned layer having a first ferromagnetic layer closest to the free layer, wherein the at least one spin tunneling junction portion includes a second pinned layer having a second ferromagnetic layer closest to the free layer, the first ferromagnetic layer being pinned in a first direction, and the second ferromagnetic layer being pinned in a second direction opposite to the first direction.

26. The method of claim 16 wherein the at least one magnetic element has a plurality of sides and wherein the at least one stress-assist layer surrounds the plurality of sides of the at least one magnetic element.

27. The method of claim 16 further comprising:
(c) providing a plurality of word write lines; and
wherein the at least one stress-assist layer resides between the plurality of word lines and the at least one magnetic element.

28. The method of claim 16 wherein the stress-assist providing step (b) further includes the steps of:

(b1) providing the stress-assist layer including at least one of a piezoelectric and an electrostrictive material.

29. The method of claim 16 wherein the stress assist layer further includes bilayer of at least one of IrO_2/PZT , MnO/PZT , TiO_y/PZT , $\text{Al}_2\text{O}_3/\text{PZT}$, $\text{Al}_2\text{O}_3/\text{PMN}$, $\text{Al}_2\text{O}_3/\text{SrBaTiO}_3$, SiO_2/PZT or $\text{SiO}_2/\text{SrBaTiO}_3$, where PZT is $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$, wherein PMN is $\text{PbMn}_{1-x}\text{Nb}_x\text{O}_3$ with PbTiO_3 and wherein x is a fraction less than 1.